

Onboard Optical Navigation Measurement Processing in GEONS

Completed Technology Project (2013 - 2016)



Project Introduction

Optical Navigation (OpNav) measurements derived from spacecraft-based images are a powerful data type in the precision orbit determination process.

OpNav measurements are an enabling data type for small body proximity operations and are required to successfully navigate a spacecraft in the vicinity of asteroids, comets, and planetary satellites. Furthermore, onboard OpNav measurement processing and autonomous navigation have operational advantages compared to traditional ground-in-the-loop orbit determination. Therefore, NASA has a strategic interest in developing in-house OpNav data processing for onboard autonomous navigation.

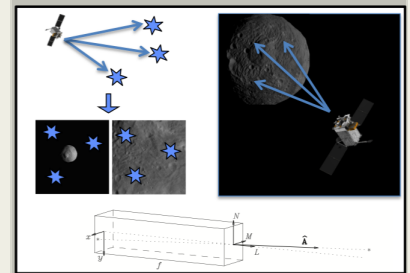
The purpose of this IRAD is to develop in-house OpNav software tools and expertise to support the next generation of interplanetary and small body missions. Upon completion of this development effort, current onboard navigation software (GEONS) will be enhanced to use high-fidelity camera models for optical navigation measurement processing.

The objective of this IRAD is to establish in-house onboard OpNav measurement data processing capabilities through software development and testing. Software development will include: 1) celestial and terrain-relative OpNav data processing, 2) high-fidelity camera modeling, and 3) onboard orbit determination software integration and testing.

Upon successful completion of this IRAD, enhancements to the Goddard Enhanced Onboard Navigation System (GEONS) will allow onboard orbit determination using optical navigation image data for interplanetary and small body spacecraft operations. GEONS will ingest and process celestial and terrain-relative OpNav data in the form of control points (pixel/line) located in an image. The processed measurements are then used to supplement radiometric data in the onboard orbit determination solution and produce real-time estimates of the spacecraft's position and velocity relative to the target body. The resulting navigation solutions will enable near-real time control, maneuver planning, and hazard avoidance for complex proximity operations. GEONS was chosen as the target platform because of its high heritage and operational use as an onboard spacecraft navigation system.

Anticipated Benefits

Supplementing current onboard navigation software with OpNav data processing capabilities will better position NASA to execute future missions to asteroids, comets, and planetary satellites. Future small body mission opportunities include Discovery-class science missions, robotic precursors and captures for human near-Earth asteroid (NEA) missions, and the human NEA missions themselves. The most recent Planetary Decadal Survey specifically highlights mission opportunities to small bodies, including asteroid and comet sample return missions, and precision touchdown on a planetary surface. Furthermore, the experience gained and software developed with this IRAD



Notional description of Optical Navigation

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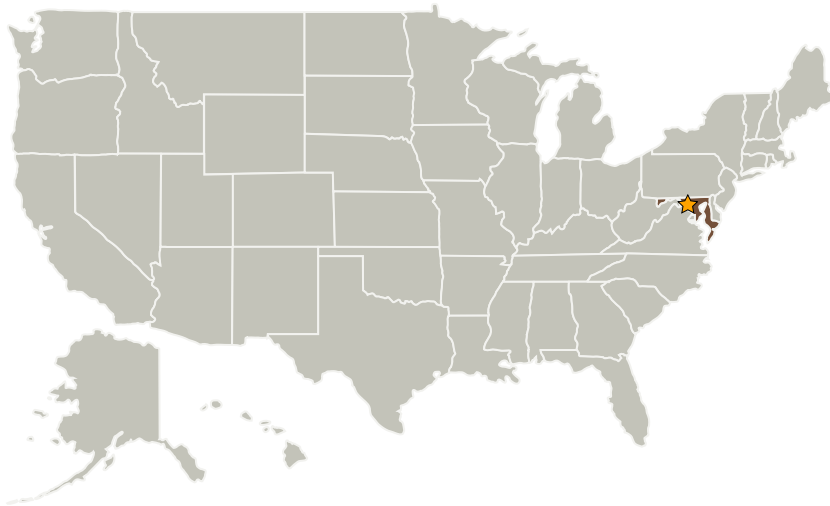
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will support future development efforts for the next generation of autonomous navigation systems, including autonomous rendezvous and docking systems for spacecraft servicing applications.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations

Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Dennis W Woodfork

Principal Investigators:Kenneth M Getzandanner
Cinnamon A Wright**Co-Investigator:**

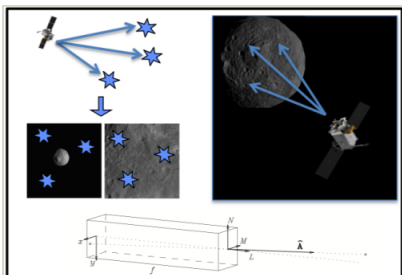
John A Gaebler

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Images



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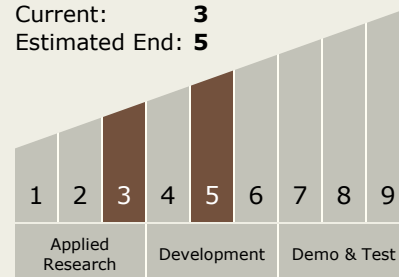
(<https://techport.nasa.gov/image/38464>)

Project Website:

<http://aetd.gsfc.nasa.gov/>

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **5**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
 - └ TX17.2 Navigation Technologies
 - └ TX17.2.1 Onboard Navigation Algorithms